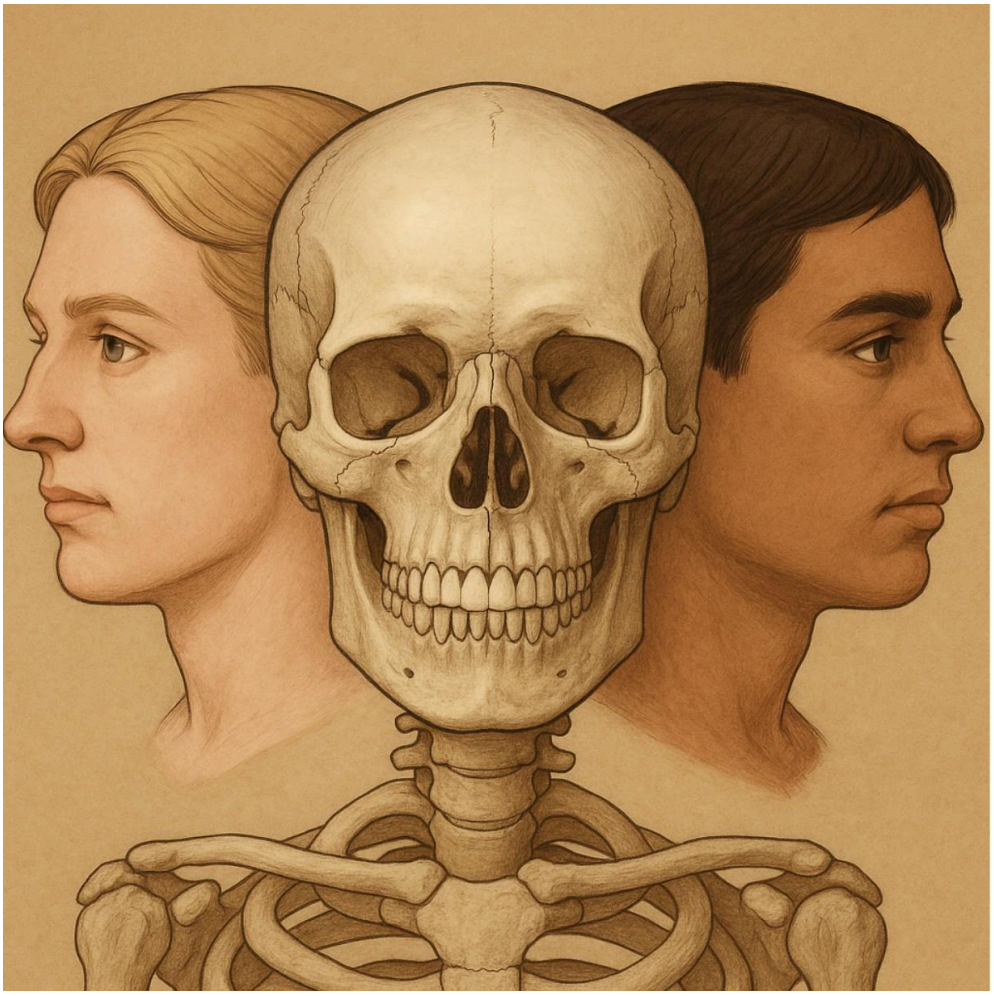
(Part IV)

The Mirror-Twin Paradox:

Resurrecting Faces, Reversing Genomes —
3D Facial Reconstruction through the Lens of the Mirror-Twin Hypothesis



Follow (Part III) The Mirror-Twin Paradox: A New Approach to DNA
Understanding the Implications of an Inverted Genome and Its Applications in Molecular Genetics, Neuroscience, and Medicine

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Preface

For centuries, the human skull has fascinated both scientists and artists. It is at once a biological matrix, an archaeological remnant, and a symbolic vessel of identity. Its shape, proportions, and anomalies tell a story—one of an individual, a community, or an entire era.
But what if, beyond the bone structure, we could explore its genetic double?
Not a clone, nor a perfect copy, but an inverted version—a mirror twin, generated through the systematic transformation of its DNA code.

This book was born from that radical question:
What if an inverted genome could give rise to an alternative face—biologically plausible, yet never born?

As an independent researcher in molecular genetics specializing in paleogenetics, bioarchaeology, and 3D reconstruction, I have spent years studying biological and digital chimeras, modeling ancient skulls, and restoring faces erased by time.
But my work took a new turn when I imagined—and then generated—a mirror genome, based on a rigorous inversion algorithm (A↔G, C↔T).
Although this genome does not exist in nature, it was nevertheless recognized as authentic by major genealogical databases.
Even more astonishingly, it was matched with real individuals, establishing familial ties with living people.
The mirror twin had been "accepted" by the system—as if it had always existed.

This project fully came to life during my training at the Yale Peabody Museum of Natural History, where I earned a certificate in natural and scientific illustration.
My final project focused on the 3D reconstruction of a trepanned medieval skull, compared with two other specimens from the Neolithic and the modern era (~150 years ago).
I chose the medieval skull for its unique anatomical features and the presence of a postmortem trepanation—revealing fascinating medico-religious practices—as well as a rare persistent metopic suture, suggesting limited genetic mixing.

This work draws on over 1,000 hours of specialized training, including:

- practical courses in ancient DNA extraction, paleogenetics, evolutionary genetics, osteometry, and bioarchaeology in France (Musée de l'Homme);

- advanced workshops in scientific illustration, 3D modeling, visual effects, and artificial intelligence, including a 330-hour program at the Yale Peabody Museum of Natural History, with specialized courses in comparative anatomy;

- and ongoing dialogue with leading researchers and anatomists.

In this book, I propose to explore the scientific, technical, and philosophical implications of the mirror-twin paradox through a concrete object: the human skull—both as a bony archive and a reconstructable matrix.

Starting from the reconstructed medieval specimen, I extend the reflection beyond the visible: toward theoretical faces, derived from inverted versions of the genome—faces that point to erased evolutionary paths we can now model, observe, and compare.
These possible faces, these forms that never came to be, compel us to reconsider what we believe to be fixed in biology. They challenge the boundaries between the real, the probable, and the virtually plausible.

What if the memory of life resided not only in what DNA has transmitted to us—but also in what it *could have become*?

This project is the continuation of my previous writings and research:

(Education K-12) **Natural Pedagogy of Logical States**: Developing Naturalistic Intelligence, from the Montessori Sensory Approach to Space Botany.

(Part I) **Explorer of Subatomic, Atomic, Genetic, Extragalactic, and Invisible Worlds**. From the Infinitely Small to the Infinitely vast — this is how I see the Universe. Direct link: https://sites.google.com/view/opticsandparticles
Everything started with this website and my early experiments. I wanted to understand how life could emerge from subatomic particles... This led me to an internship at CERN, to a rather unique journey around the world through physics laboratories, and eventually to the beginning of my studies in genetics.

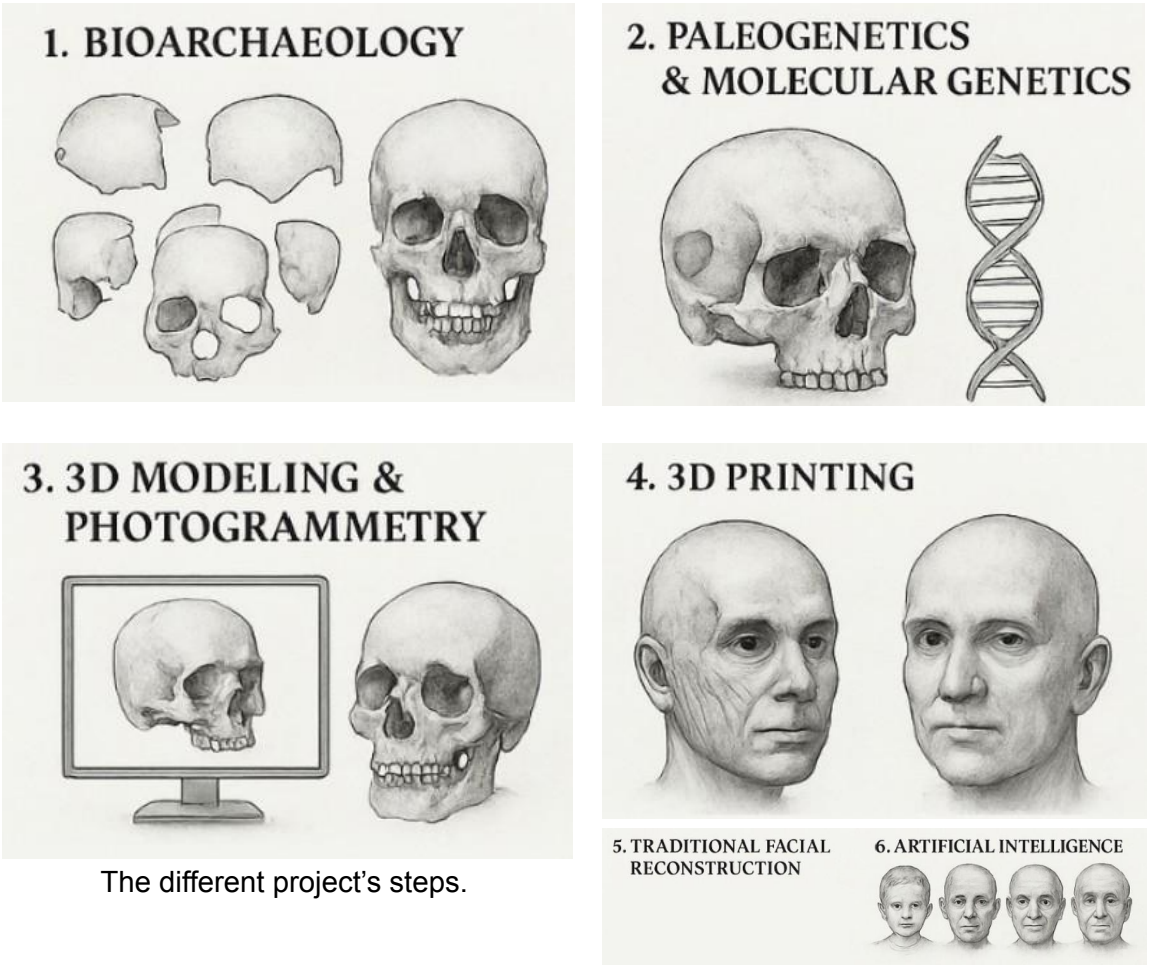
(Part II) **Biological and Artificial Human Chimeras** (Biological Anthropology and Human Evolution). Direct link: https://zenodo.org/records/15518671

(Part III) **The Mirror-Twin Paradox: A New Approach to DNA. Understanding the Implications of an Inverted Genome and Its Applications in Molecular Genetics, Neuroscience, and Medicine.**
Direct link: 10.5281/zenodo.15390048

(Part IV) **The Mirror-Twin Paradox: Resurrecting Faces, Inverting Genomes: 3D Facial Reconstruction through the Mirror-Twin Paradox Lens.**

(Part V) **The Mirror-Twin Paradox: Evolution 2.0: Decoding the Genetic Code and the Future of Intelligence** (in progress)**.**

Part I – Anatomy of a Method



The different project's steps.

Chapter 1: From Dust to Form – Stages of a Cranial Reconstruction

Cranial reconstruction is not merely a technical exercise. It is a delicate process that brings together anatomy, archaeology, paleogenetics, and scientific imagination. The goal is not only to restore a face to an ancient skull, but to understand what that face reveals about evolution, biological memory, and human identity.

1. From the Ground to the Laboratory: Collection, Cleaning, and Documentation

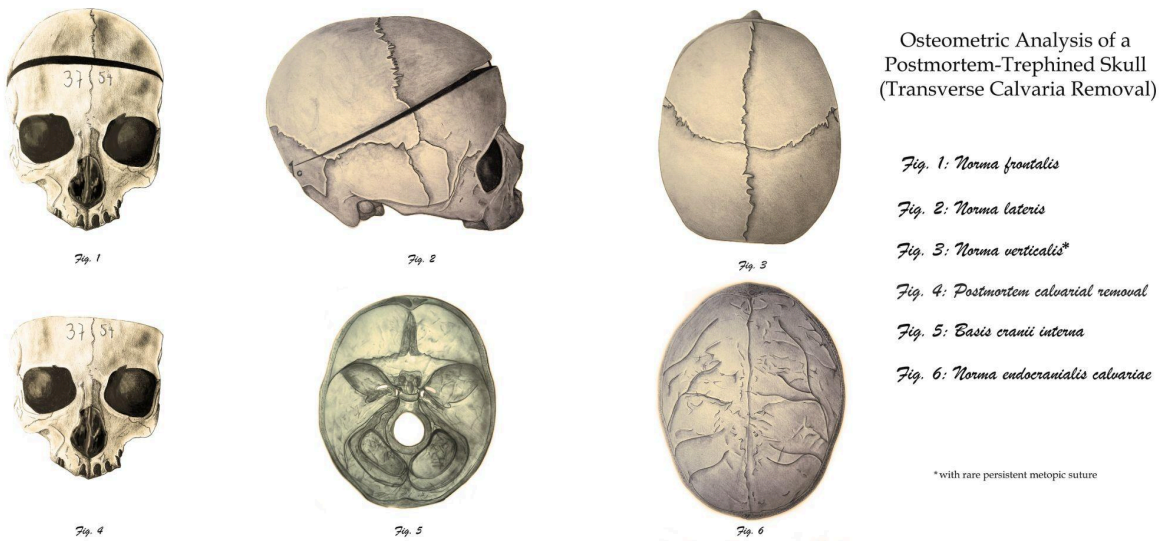
It all begins with discovery. Whether it comes from an archaeological site, a rescue excavation, or a museum collection, the skull is initially a fragile object—often fragmented, sometimes incomplete.

Initial steps:

- In situ photogrammetry and archaeological survey mapping
- Dry cleaning, sieving, and documentation of lesions and taphonomic traces
- Assessment of preservation conditions to determine the feasibility of DNA extraction (preferably from the petrous portion of the temporal bone)

Osteological study includes:

- Age at death, biological sex, stature, visible pathologies, and anomalies (e.g., rare persistent metopic suture)
- Cultural modifications (e.g., trepanation, cranial deformation, etc.)


Osteometric Analysis of a Postmortem-Trephined Skull (Transverse Calvaria Removal)
Fig. 1: Norma frontalis
Fig. 2: Norma lateris
Fig. 3: Norma verticalis*
Fig. 4: Postmortem calvarial removal
Fig. 5: Basis cranii interna
Fig. 6: Norma endocranialis calvariae
* with rare persistent metopic suture

2. Extraction and Analysis of Ancient DNA

The DNA found in medieval or Paleolithic skulls is often highly degraded. This requires adapted protocols, sterile conditions, and work within specialized laboratories.

Techniques used:

- Sectioning of the petrous portion of the temporal bone or dentine
- Decalcification, purification, followed by PCR amplification or targeted DNA capture
- Sequencing (often hybrid): short-read platforms (e.g., Illumina), occasionally long-read technologies (e.g., Nanopore)

Objectives:

- Identify the individual: biological sex, haplogroup, phenotypic traits
- Detect pathogenic mutations, inherited features, or signs of admixture
- Generate a genomic dataset suitable for use in a mirror genome reconstruction

Ancient DNA extraction directly from inside the bone using a Dremel tool,
followed by analysis of the recovered DNA.

3. Digital Acquisition: Scanning and 3D Modeling

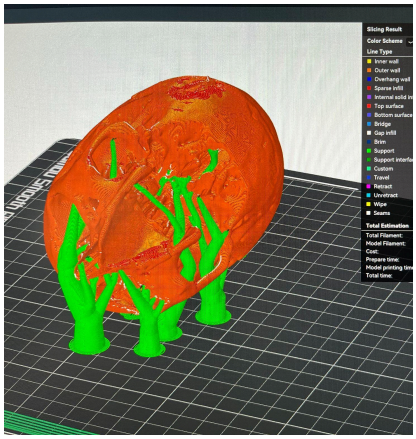
Once the skull has been cleaned and restored, it is digitized to allow for analysis and reconstruction without damaging the original specimen.

Modeling steps:

- **High-resolution laser scanning** or **micro-CT imaging**
- **Polygonal mesh reconstruction**
- **Repair of missing areas** through **interpolation** or **morphometric comparison** with reference databases

Specific approach:

In my projects, I make a point of preserving **digital traces of asymmetries, lesions, or individual-specific features**.
Where others might “clean up” the model, I integrate these irregularities as **narrative elements of biological life**.



But at this stage, the lower jaw is missing! I’ll try to sculpt it and add it manually…

4. Tissue Layering and Facial Reconstruction

This is where science meets art. Based on the 3D model of the skull, a facial reconstruction can be performed using one of two main approaches: the **anatomical method** (reconstructing each muscle layer by layer) or the **tissue-depth method** (relying on statistically derived soft tissue thickness markers).

Preferred methodology:

- Placement of **soft tissue markers** at standard **anthropometric landmarks**
- **Progressive muscle modeling**, layer by layer
- Estimation of the **nose**, **lips**, and other soft tissues using **statistical**, **ethnic**, or **genetic data**
- Application of **textures** (skin color, hair, eye pigmentation) based on known genetic variants

Limits and biases:

- A reconstruction is **never an absolute certainty**
- The **margin of error increases significantly** in soft tissue regions, and some features—such as **ears**, **hair distribution**, and **wrinkles**—remain **interpretative**

5. From Reconstruction to Genomic Projection

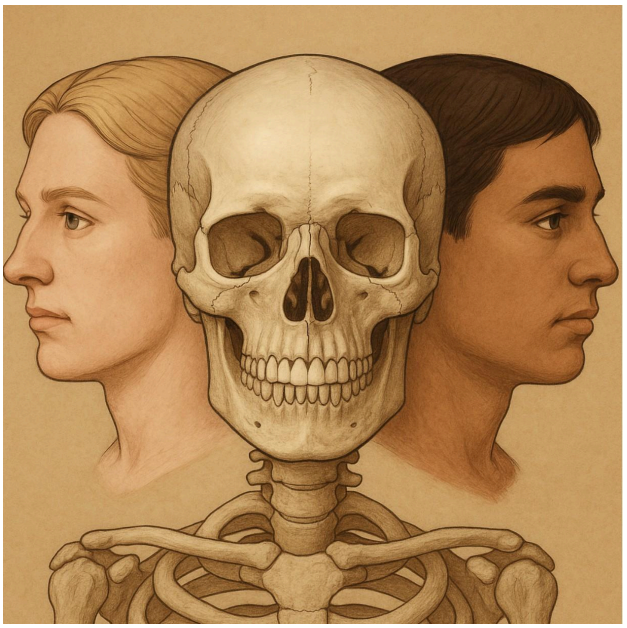
In my approach, anatomical reconstruction is **not an endpoint**, but a **starting point**. From this foundation, I proceed to project either:

- A **mirror phenotype**, based on my **inverted genome algorithm** (see *The Mirror-Twin Paradox*),
  or
- An **evolutionary simulation**: what would this face have become in an alternate genetic environment, or with an inverted genome?

This is a **speculative yet rigorous exploration**, combining:

- **Facial morphometrics**

- **Comparative genetics**
- **Neurocranial modeling**



In order to comply with ethical standards, I will continue the reconstruction process using a different skull sourced from a royalty-free 3D model library, applying the exact same methodological framework.

Chapter Conclusion

To reconstruct a skull is to resurrect a presence. It is not merely about revealing a biological structure, but about restoring a human being in their uniqueness and their possible selves.

Thanks to the contributions of paleogenetics—and my theory of mirror twins—I propose taking this process one step further: to also reveal what this individual *could have been*. Not to distort their identity, but to better understand the tensions and boundaries of our genetic humanity.

Chapter 2: Mirror Facial Reconstruction – Exploring Genetic Otherness

1. Beyond the Face: Rethinking the Face as a Genetic Interface

In forensic tradition, facial reconstruction aims to restore a face that is as faithful as possible to the individual once living.
But what if that face were just one projection among many possible ones?
What if, from the same skull, a genetically plausible—but never realized—version could emerge: an *inverted form* of that being?

This is the path I explore through the concept of **mirror facial reconstruction**, which combines:

- Traditional cranial modeling
- Classical genetic analysis (*aDNA*)
- An algorithmic inversion of nucleotides (A↔G, C↔T): the **mirror genome**

This approach is not merely speculative. It follows a rigorous experimental logic aimed at:

- Testing the **robustness of phenotypes** under extreme genetic transformations
- Identifying **latent traits** in the human genetic heritage
- Proposing a new way to think about **human evolution** and the **erased trajectories** of our species

2. Methodology: Generating a Face from an Inverted Genome

After ancient DNA extraction and 3D skull reconstruction (see Chapter 1), I proceed with a **dual phenotypic projection**:

A. Standard (Real) Phenotype

- Deriving traits from known SNPs (skin tone, eye color, lip shape, hair density, etc.)
- Facial reconstruction adjusted to **anthropometric data**, regional origin, and *aDNA* insights

B. Mirror (Inverted) Phenotype

- Applying a **complete genome inversion algorithm** (see *The Mirror-Twin Paradox*)

- New interpretation of the altered genetic variants
- Reconstruction of a **"mirror face"** based on this alternate genetic map

Result: Two faces derived from the same skull, whose traits reflect one another—like opposite sides of the same coin.

3. Case Study: The Trepanned Medieval Skull (Yale Peabody Project)

As part of my final project at the **Yale Peabody Museum of Natural History**, I modeled a **medieval skull** that had undergone **postmortem trepanation**.

From this base, I created two reconstructions:

“Original” Face

- Marked features, visible scars, robust projection
- Skin and eye color inferred from period-specific genomic data (simulated extraction based on regional phenotype)

“Mirror” Face

- Finer features, reversed asymmetries, preserved orientation of cranial sutures
- Muscular insertions adjusted based on the **mirror genome**
- Lighter complexion, larger pupils, subtly shifted facial structures—like a possible individual that never existed

4. What the Mirror Reveals: Neuroevolutionary Hypotheses

The mirror face is not just an aesthetic experiment. It opens new scientific perspectives:

- Some **inverted mutations** may **reactivate archaic or silenced traits**
- The **slightly modified cranial shape** (hypothetical axis rotation) may be linked to **inverted brain lateralization**, as seen in real monozygotic twins
- By modeling **gene expression in the brain** from the inverted genome, it becomes possible to simulate an alternate **neural map**—altering perception, emotion, pain response...

5. Limits, Possibilities, and the Philosophy of the Double

This work opens a philosophical abyss:
Are we still ourselves if our DNA is inverted, but our skull remains identical?

The mirror face is not a futuristic fantasy, but a **bio-anthropological thought tool**.
It allows us to:

- Question the **plasticity of human identity**
- Create **experimental avatars** to test hypotheses in precision medicine
- Feed the **scientific imagination** by restoring faces that evolution never selected

Chapter Conclusion

Mirror facial reconstruction does not aim to distort the past, but to extend it. It gives the ancient skull a voice, and DNA a narrative dimension. Between biological reality and controlled fiction, it offers a new language for science—a **language of possibility**.

Chapter 3: Ancient Genomes, Parallel Faces – Applying Mirror Reconstruction to Human Evolution

1. A New Perspective on Extinct Species

Since ancient DNA (*aDNA*) was first successfully extracted from Neanderthal remains, the study of human evolution has entered a new era. These fossil genomes are no longer mere molecular archives—they are reactivatable fragments of human history. From them, we can now model faces, cognitive traits, and even interactions between species.

But what if we applied a systematic transformation to these ancient genomes—a **mirror genome**?
What if we could reconstruct not only what these species *were*, but what they *could have become*, along an **inverted evolutionary trajectory**?

2. Experimental Hypothesis: Inverting a Neanderthal Genome

Applying the A↔G / C↔T inversion algorithm to the complete Neanderthal genome could produce several observable phenomena:

- **Ultraconserved regions** may become unstable—allowing us to pinpoint **evolutionary constraint zones**
- Alleles associated with **bone robustness** or **cold tolerance** may become **dysfunctional**
- Combinations of SNPs that are “neutral” in the original genome could become **pathogenic** in their inverted form—revealing potential **silent compensatory mechanisms** in actual evolution

Projecting the **mirror genome** onto a **scanned Neanderthal skull** could then generate an **alternate face**: bioinformatically plausible, but never seen in nature.

3. Toward a Controlled Speculative Paleoanthropology

The mirror face of a Neanderthal is not a gimmick—it enables us to:

- Test the **structural viability** of a genome under extreme constraint
- Identify genes whose inversion renders life **incompatible**, thus mapping **evolutionary bottlenecks**
- Simulate **erased evolutionary paths**: What if Neanderthals had survived—with a partially inverted genome?

- Better understand interactions between *Homo sapiens* and other hominins: some known genetic compatibilities (e.g., in hybrids) might **invert** under the mirror model, revealing **hidden mechanisms** of fertility or sterility

4. Application to Other Species: *Homo floresiensis*, Denisovans, Australopithecines?

- For **Denisovans**, known only from a few phalanges and teeth, the mirror genome allows us to **test hypothetical reconstructions**, offering a broader palette of traits based on partial genetic data

- For **Homo floresiensis**, whose phylogenetic status remains debated, mirror projections could reveal **unexpected convergences** with modern lineages

- Even in the absence of DNA (e.g., **Australopithecines**), a **theoretical mirror genome** could be inferred through **osteological markers** and **comparative morphometric matrices**

5. Bridging 3D Modeling, Paleogenetics, and Experimental Fiction

This work proposes a new framework for **augmented paleoanthropology**:

Far from a purely artistic exercise, **dual reconstruction** (original + mirror) allows us to probe **evolutionary limits** by revealing the **structural constraints** of a skull under a transformed genome.

This method could also serve as a **testing ground for AI**: feeding **deep learning models** with mirror genomes from multiple species could allow us to **predict evolutionary breakpoints**, **compensatory zones**, or **unexplored adaptive potentials**.

Chapter Conclusion

Exploring extinct human species through the lens of the mirror genome is like unlocking an **evolutionary palimpsest**. The faces it generates—parallel, inverted, plausible yet unrealized—remind us that evolution is but one path among many.

What we became is only one version among an infinity of possible selves. In that sense, the genetic mirror is not fiction—it is a **revealer of humanity**.

Chapter 4: Mirror Skull, Mirror Brain – Toward a Speculative Neurogenetics

1. The Brain as an Evolutionary Reflection

The human brain is one of the most **plastic**, yet most **enigmatic** organs of evolution. Its structure is largely determined by **early genetic factors**, though shaped over time by environmental input.

But what would happen to **brain architecture** if a human genome were inverted according to the **mirror-twin principle**?

Studies on monozygotic twins already show **partial inversions** in brain lateralization, handedness, and the localization of language functions. These clues suggest that **inverting the genetic code** could lead to an **alternate brain organization**.

2. Extrapolation Methods: From DNA to the Theoretical Brain

Using **genetic atlases** of neural expression, we can identify genes involved in **neuronal differentiation**, **synaptic connectivity**, and **neurotransmitter production**.

By applying **mirror inversion** to these genes, we can simulate an **alternative cerebral map**, observing possible **inversions in activation patterns**, **polarity**, or **functional dominance**.

This modeling can be integrated into **digital twins**, or tested in **brain organoids** derived from **genetically modified iPS cells**, offering experimental insights into these inverted configurations.

3. Functional Consequences: Perception, Memory, Cognition

A mirror brain could potentially present:

- **Right-hemisphere language dominance**
- **Enhanced spatial memory**, but altered sequential logic
- **Sensory hypersensitivity**, or **asymmetric facial recognition**

Though speculative, these hypotheses pave the way for a better understanding of **natural neurocognitive variations**, and for the **controlled creation** of **alternative neural architectures**—including **biomimetic AI systems**.

4. Ethics and Limits of Experimental Neurogenetics

Working with **theoretical or experimental brains**—whether generated *in silico* or grown *in vitro*—raises major ethical questions:

- At what point does an **inverted brain organoid** become **conscious**?
- Is it legitimate to generate a **mirror brain** to study **alternate intelligence**?
- What **rights** might be owed to these experimental entities if they express **forms of cognition** or **emotion**?

Chapter Conclusion

The skull, as the biological container of the brain, becomes a **gateway** to broader reflection on **speculative neurogenetics**. By inverting the genome, we are not merely reconstructing a face—we are **suggesting another mental cartography**, another cognitive self, perhaps even **another mode of existence**.

The mirror twin does not think like us—and **that** is precisely what makes its reconstruction so valuable.

Part II – Parallel Genomes and Erased Trajectories

Chapter 5: Lost Faces, Possible Faces

1. Reconstructing Extinct Human Species

Since the partial sequencing of Neanderthal DNA—and later, that of the Denisovans—paleogenetics has revealed that the modern human species is the result of a complex history of interbreeding, extinction, and inheritance.

But what if we applied mirror inversion to these ancient genomes? Could we reconstruct alternate faces—phenotypes that never came to be, yet remain biologically plausible?

2. Theoretical Experiment: Mirror Neanderthal

A Neanderthal genome inverted using the A↔G / C↔T model could be generate entirely new variant sequences.
Initial simulations might suggest alterations in pigmentation genes, bone metabolism, and neural connectivity.

By projecting this mirror genome onto a Neanderthal cranial model, a new face could be emerge: finer features, a slightly higher forehead, a modified gaze—an unexpected yet coherent phenotype.

3. *Homo floresiensis*, Denisovans, and Other Lineages

In the case of *Homo floresiensis*, mirror projection could allow for testing models of inverted dwarfism or adaptive specialization.

For Denisovans, whose fossil record is extremely limited, the mirror approach could provide a framework for theoretical facial reconstruction, by combining genomic data with known morphometric matrices.

4. Fictional Anthropology and Biological Constraint

These inverted faces, while born from a framed fictional process, allow us to test the stability of human forms. They raise a key question: *How far can life diverge and still remain viable?*

In this sense, genetic inversion becomes a tool for exploring human plasticity—as valid as the study of natural mutations.

Chapter 6: Augmented Skulls and Maps of the Impossible

1. From Reconstruction to Theoretical Design

Digitized 3D skulls can serve not only as the basis for faithful reconstructions but also for theoretical extrapolations. What would happen if we altered facial-to-vault proportions, maxillary projection, or cranial volume, based on inverted gene sequences?

2. Mirror Skulls in Simulated Evolution

By using evolutionary simulation tools, such as artificial morphogenesis networks, we can generate entirely hypothetical mirror lineages of skulls. These skulls can then undergo biomechanical viability testing, or be compared to rare fossil specimens to explore surprising convergences.

3. Artificial Intelligence and the Skulls of the Future

AI can assist in generating hybrid skulls, blending real and inverted data. It can also detect shared patterns between historical and hypothetical crania.

This approach opens the door to a predictive anthropology, where the forms of the past intersect with the potentials of the future.

Conclusion of Part II

Exploring extinct species through the generation of mirror faces and skulls is a way to probe the blind spots of our evolution. It reminds us that human history is not linear, but filled with bifurcations, erased possibilities, and forms that never came into being. Through science, we can bring these forms to light—not to fantasize them, but to better understand the fragile singularity of who we are.

Part III – Artificial Intelligence and Virtual Twins

Chapter 7: The Digital Twin – Toward an Embodied Simulation

1. What Is a Digital Twin?

In industry and medicine, a **digital twin** is a dynamic model, continuously updated, capable of simulating the behavior of an individual or system.
When applied to the human body, it enables the modeling of an organ, a nervous system—even a full individual.

The concept of the **digital mirror twin** goes a step further: it involves generating an **inverted yet plausible version** of a given individual by combining their **mirror genome**, a **facial reconstruction**, and a **simulated cognitive architecture**.

2. Creating the Virtual Mirror Twin

The process includes:

- **Inversion of the genome** and projection of associated phenotypic traits
- Application of **neural models** inspired by brain organoids or gene expression maps
- Integration into a **3D animated interface** (as an avatar or AI agent)

This **mirror twin** becomes a **simulable object of study**: its behaviors, perceptions, responses to stimuli, and adaptability can be tested in various **virtual environments**.

3. Scientific, Memorial, and Educational Applications

- In **neuroscience**: testing inverted cognitive profiles
- In **bioethics**: questioning the notion of the simulated person
- In **archaeology**: giving voice to the dead through interactive interfaces (museums, reconstructions)
- In **education**: developing embodied learning tools to explore human evolution

Chapter 8: Toward Organic AI?

1. AI, DNA, and Hybrid Cognition

Current artificial intelligence is inspired by neural function but remains disconnected from biological material.
However, recent research explores **biohybrid AI**—fusing **living neurons** with **computational architectures**.

My work proposes an additional step: using a **mirror genome** to guide the differentiation of a **brain organoid**, interfaced with an artificial learning system.
This AI would be built from a code that is both **real and inverted**—a different mode of intelligence, born from **another genetic space**.

2. Prospective Experimental Protocol

- Selection of a **mirror genome**
- Differentiation of **iPS cells** into **neural organoids**
- **Electrophysiological interfaces** to capture signals
- Training in a **simulated environment** (VR or cognitive games)

3. A Mirror AI to Understand the Human

This AI would not aim to replicate the human brain, but rather to **explore an emergent form of intelligence**, arising from an alternative genetic base.
It could reveal **radically different forms** of perception, memory, or language—yet **compatible** with certain atypical human conditions, such as **neurodivergence**.

Conclusion of Part III

The **mirror twin**, whether digital or organic, opens a new path toward an **anthropology of possibilities**.
It is no longer just about reconstructing the past, but about exploring the margins of the human—those paths **evolution did not choose**, but that science can now simulate.

In this mirror, **we may be glimpsing our own future**.

Final Conclusion – The Skull, the Mirror, and the End of Race

Originally, skulls were measured to **classify**, **rank**, and **exclude**.
For centuries, they were used to support pseudo-scientific narratives about race, intelligence, and civilization.

But today, through **genetics**, **3D modeling**, **artificial intelligence**, and **speculative biology**, the skull becomes something else:
A **medium for emancipation**, a **revelator of diversity**, a **mirror of possibilities**.

By projecting different phenotypes onto the same skull, by inverting genetic sequences to reveal a “mirror twin,” by modeling theoretical faces that have never existed, I have sought to **detach appearance from identity**, to demonstrate that what we call “racial traits” is merely the **fragile, reversible, and localized expression** of an extraordinarily **plastic genome**.

This is not about denying differences, but about **repositioning them within an evolutionary and molecular continuum**, where no trait is superior, stable, or pure.
Racial classifications are biologically inconsistent, historically constructed, and scientifically obsolete.
What mirror reconstruction reveals is that **otherness is not the opposite of the self, but a possible variation of it**.

By deconstructing the **visual and genetic foundations** of racial assignment, this work reaffirms a fundamental truth:

> **Humanity is a form in motion, a space of variation—not a sum of categories.**

The printed skull, the modeled face, the inverted genome… these are not fictions: they are **critical tools**.
They enable us to reconstruct not only faces, but also the ways we **see**, **think**, and **tell the story of who we are**.

It is in this mirror—**inverted but lucid**—that we begin to glimpse what comes **after biology**:
A place where science is no longer a tool for exclusion, but a **medium for connection**.

> *And what if the memory of our species consisted not only of what we have been, but of everything we could have become?*

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